UTILITY OF NUCAPS RETRIEVED PROFILES TO DIAGNOSE EXTRATROPICAL TRANSITION

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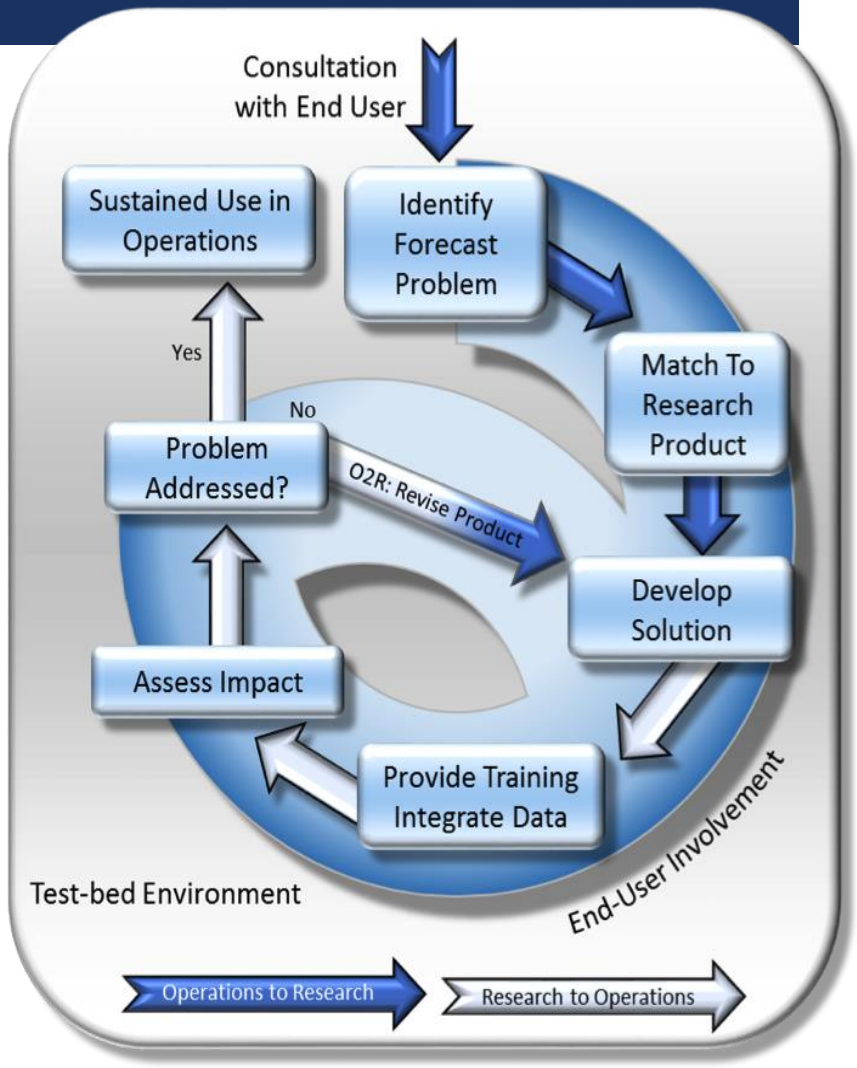
NASA SPORT
Short-term Prediction Research and Transition Center

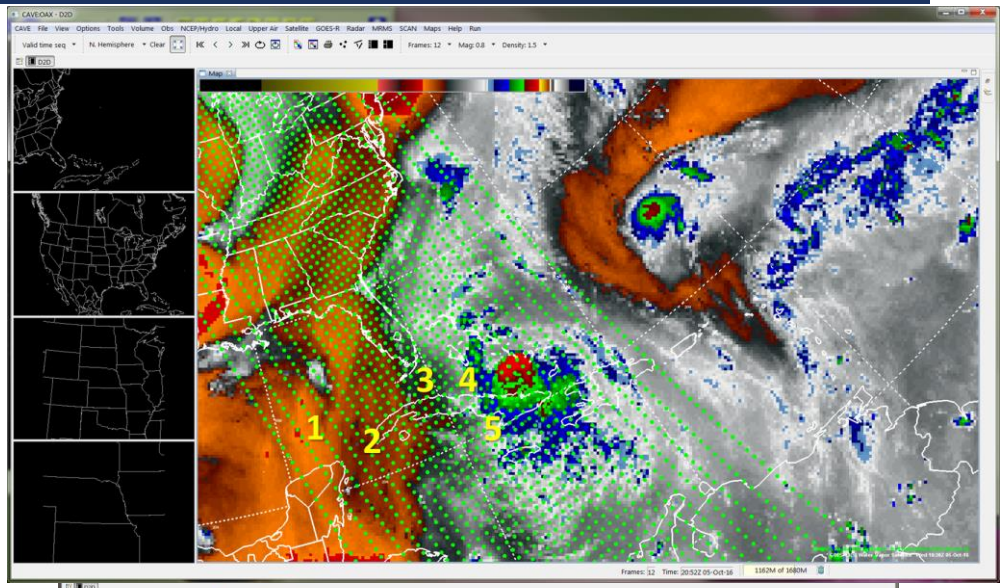
NASA/SPORT MISSION AND PARADIGM

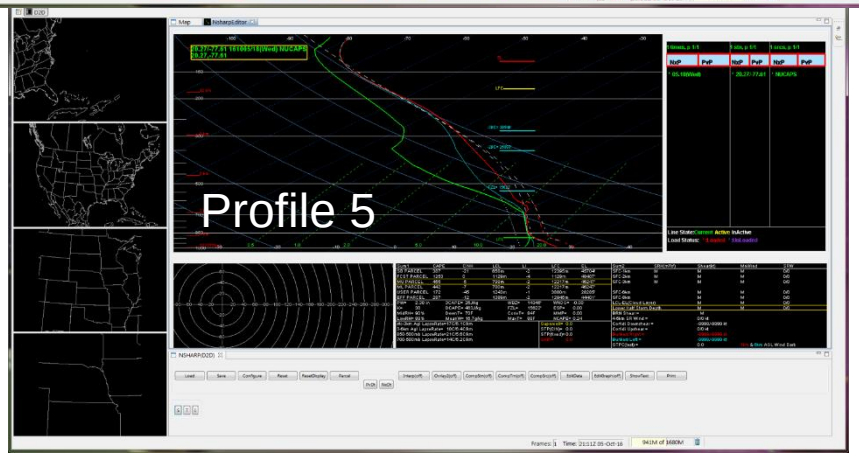
- ***Apply satellite measurement systems and unique Earth science research to improve the accuracy of short-term weather prediction at the regional and local scale***
- Bridge the "Valley of Death" between research and operations
- Can't just "throw data over the fence"
  - Maintain collaborative partnerships with end users via help of local "SPoRT" advocates
  - Integrate product into user decision support tools for use with existing data
  - Create forecaster training on product utility
  - Perform targeted product assessments to determine operational value
- Concept has been used to successfully transition a variety of satellite datasets to operational users for nearly 10 years



INTRODUCTION

- SPoRT is working with the JPSS Proving Ground and the National Hurricane Center to testbed the utility of CrIS/ATMS Soundings to anticipate hurricane tropical to extratropical transition
- CrIS/ATMS Soundings are processed through the NOAA Unique Combined Atmospheric Processing System (NUCAPS) and available to forecasters in AWIPS
- This project focuses on an additional application for NUCAPS soundings and investigates their utility for anticipating stratospheric drying in the pre- and post-extratropical transition (ET) environment.



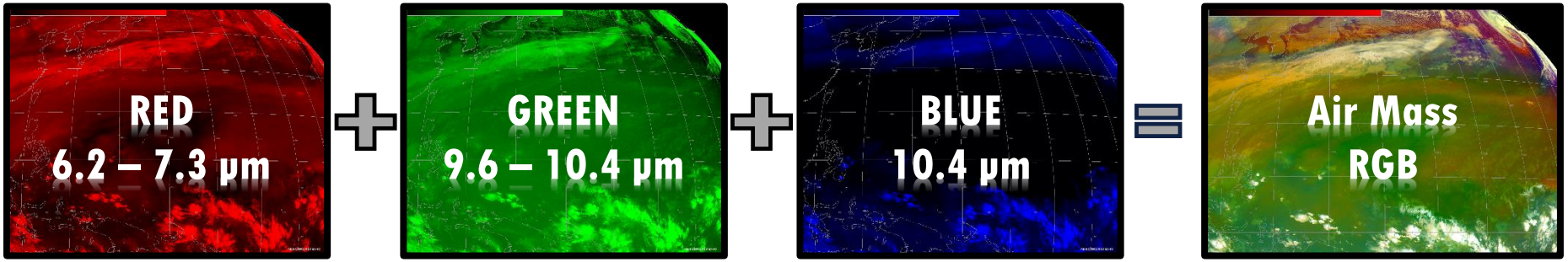


PROJECT OBJECTIVES

- Demonstrate how NUCAPS infrared retrieved temperature, moisture, and ozone profiles can complement the Air Mass RGB imagery by giving forecasters insight about the vertical distribution atmospheric variables that are important for anticipating tropical to extratropical transition events.
- Develop an enhanced stratospheric depth product derived from NUCAPS retrieved profiles to compliment the Air Mass RGB product for this forecasting application.
- Create short-applications based training material.
- Conduct a product demonstration/testbed with the National Center forecasters in conjunction with the JPSS Proving Ground.

AIR MASS RGB

- The Air Mass RGB product provides forecasters with an enhanced view of various air masses that are combined into a single image and can help differentiate between
  - possible stratospheric/tropospheric interactions
  - moist tropical air masses, warm/dry tropical air masses, and cool, continental/maritime air masses.
- Since the Air Mass RGB can only detect mid- to upper level features, Satellite soundings can provide valuable information about the vertical distribution of temperature/moisture and complement the RGB

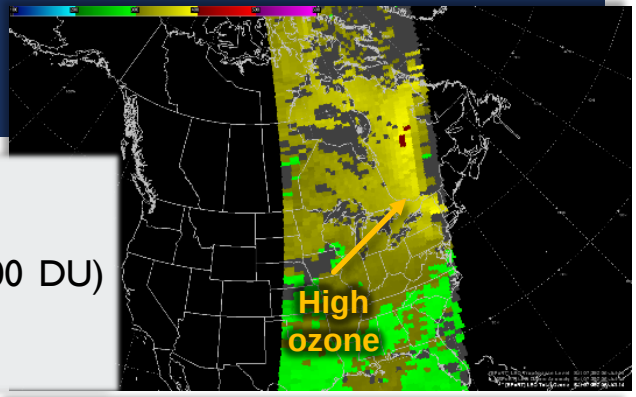


Red/Orange → Vorticity/Jet Streak, dry air pulled down on anticyclonic side of the jet
Olive → Warm, mid-upper level dry air
Green/Blue → warm (cool), mid-upper level moist air

SPORT OZONE PRODUCTS

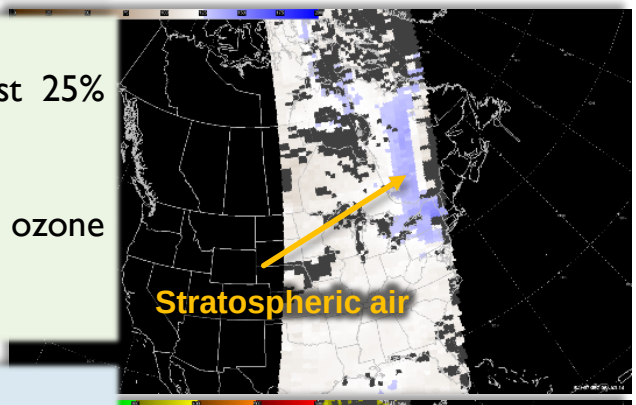
Total Column Ozone (Dobson Units)

- High ozone is a tracer for stratospheric air and tropopause folding
- Identification of stratospheric air based on high ozone alone (e.g. 300 DU) can be misleading since ozone values vary by season and latitude
- Produced from AIRS, IASI, and CrIS



Ozone Anomaly (Percent of Normal)

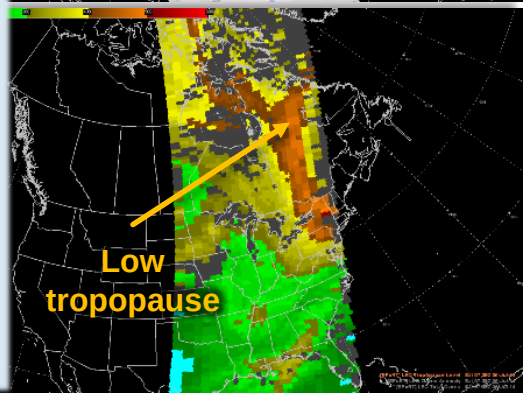
- Stratospheric air can be identified where ozone values are at least 25% greater than the climatology (Van Haver et al. 1996)
- Product displayed in Percent of Normal 0-200%
- Shades of blue (values >= 125%) indicate stratospheric air and the ozone values are anomalous for the month and latitude (Ziemke et al. 2011)
- Produced from AIRS, IASI, CrIS



Tropopause Level (Millibar)

- Ozone can be used to identify the tropopause level, use of a single value (e.g. 100 ppb) is misleading
- The seasonal variation of ozone at the dynamic tropopause (2 PVU) is described by Thouret et al. (2006)

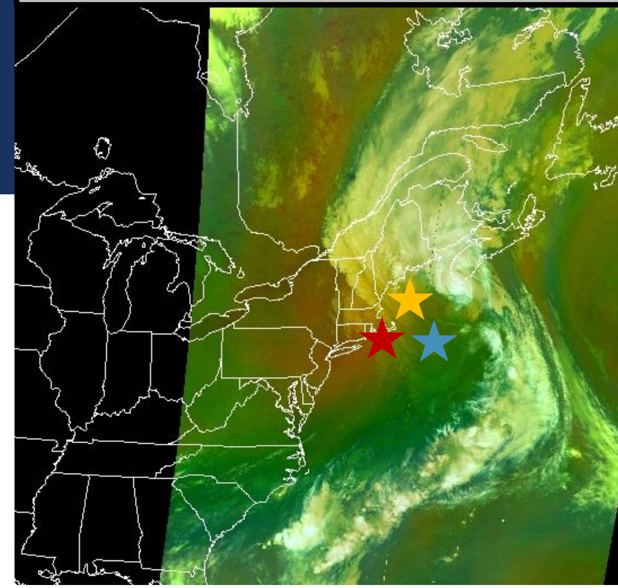
  $91 + 28 \sin(\pi*(\text{month}-2)/6)$
- Tropopause level is found by matching the level where the ozone value is greater than or equal to the Thouret et al. (2006) value
- Produced from IASI and CrIS

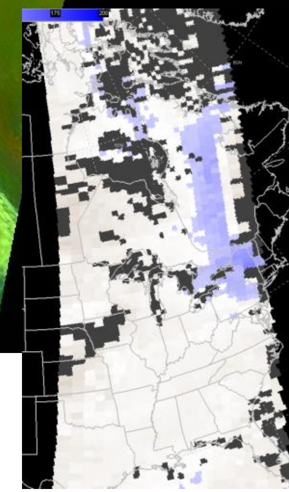


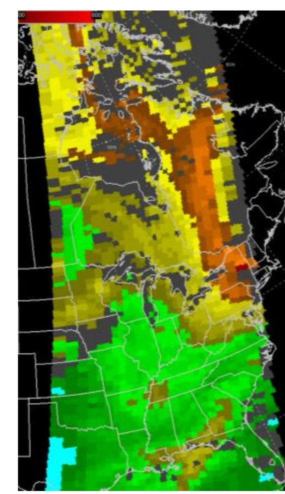
ARTHUR (2014)

- Arthur interacted with and become embedded in the mid-latitude flow and accelerated northeast 4-5 July
- The storm began ET and weakened to a tropical storm by 0600 UTC 5 July near Cape Code, MA

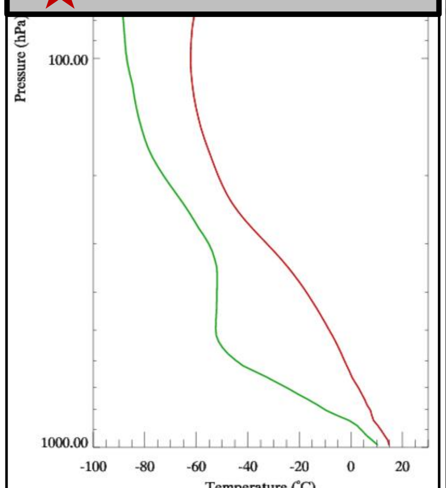
AQUA MODIS Air Mass 5 July 2014 0635-0645 UTC



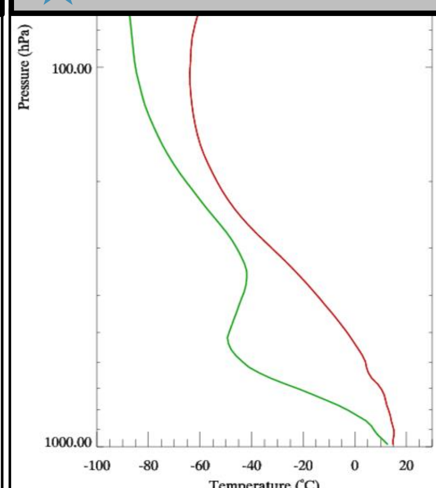




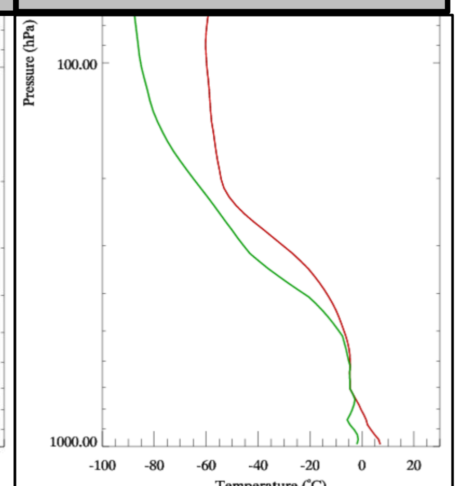
NUCAPS Sounding 5 July ★ 0745-0755 UTC



NUCAPS Sounding 5 July ★ 0745-0755 UTC



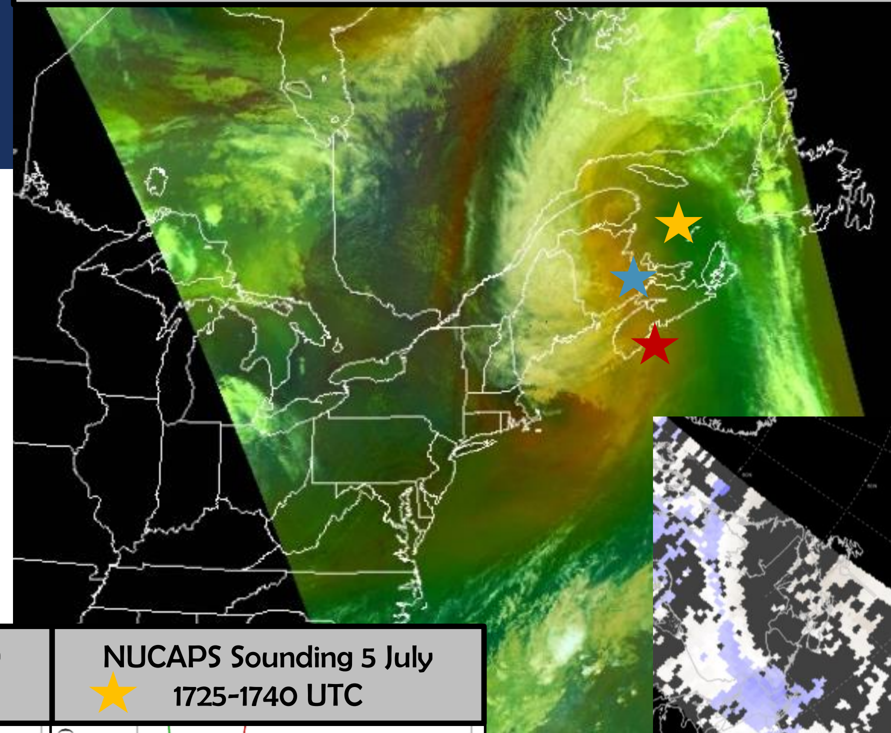
NUCAPS Sounding 5 July ★ 0745-0755 UTC

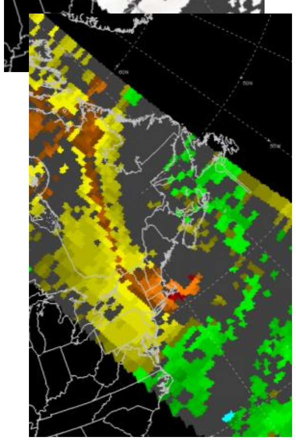


ARTHUR (2014)

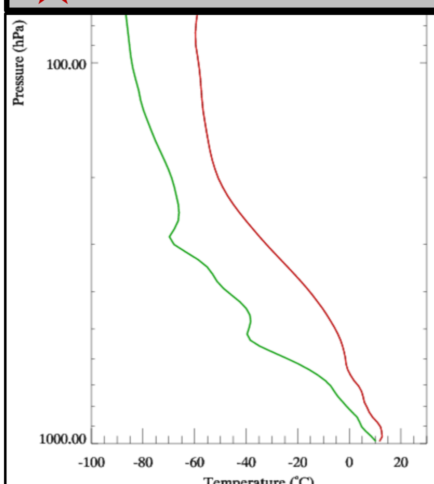
- Arthur (2014) was classified as ET by 1200 UTC 5 July
- The ET low continued moving NE producing gale-force winds/heavy rain
- By the 1700 UTC analysis dry air had penetrated the storm

AQUA MODIS Air Mass 5 July 2014 1735-1750 UTC

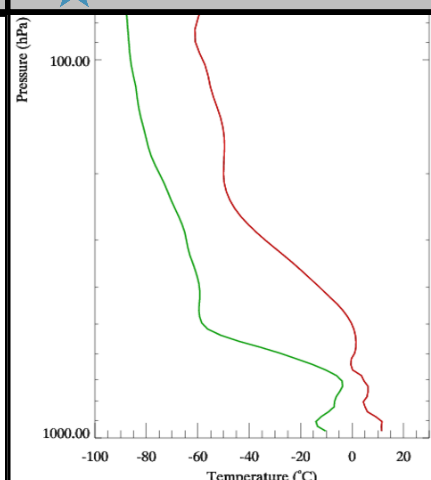




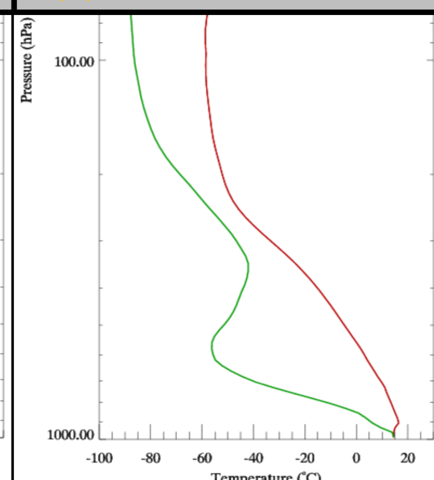
NUCAPS Sounding 5 July 1725-1740 UTC



NUCAPS Sounding 5 July 1725-1740 UTC



NUCAPS Sounding 5 July 1725-1740 UTC



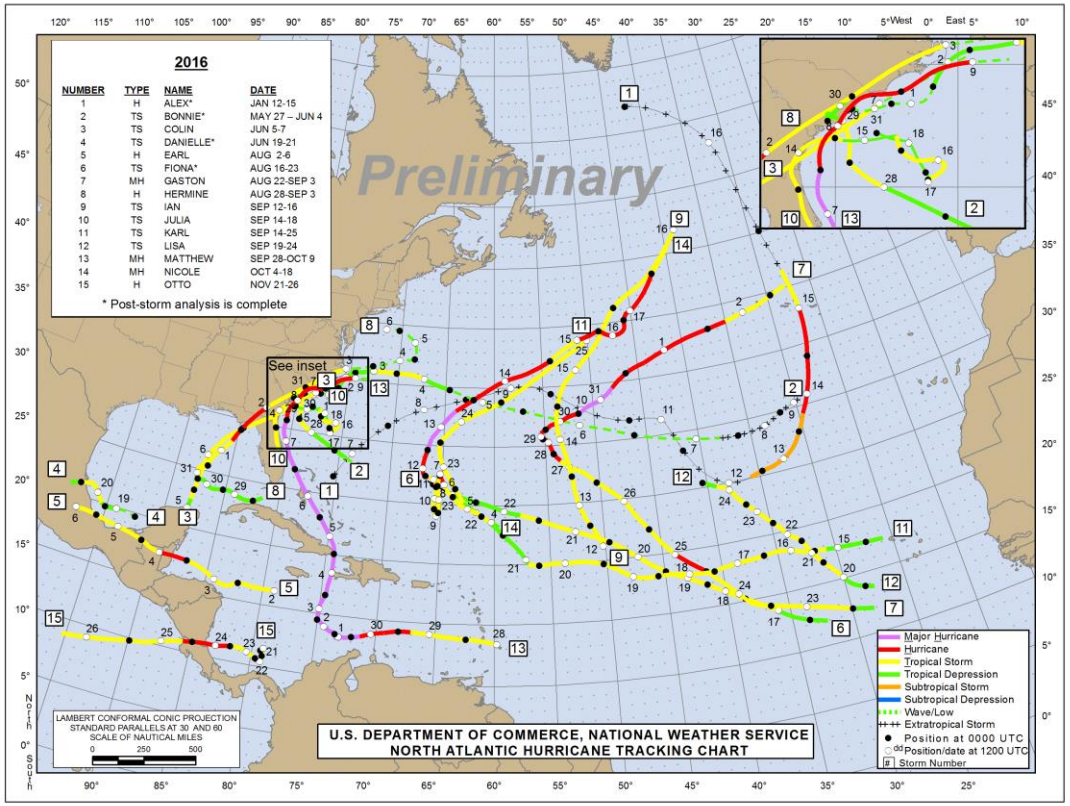
TRAINING

Analyzing the complex environment favorable for hurricane tropical to extratropical transition can be challenging, especially in data sparse regions. This short module provides an overview of JPSS Proving Ground satellite products, Air Mass RGB, NUCAPS Soundings, and SPoRT Ozone products, available to diagnose the influence of stratospheric air during extratropical transition. This module is 7-10 minutes of audio and user interaction. The interactive application example focuses on the use of these products for the extratropical transition of Arthur in 2014.

https://nasasporttraining.wordpress.com/2016/07/21/jpss-satellite-products-for-extratropical-transition/

TESTBED ACTIVITIES

- Traveled to NHC in July to discuss NUCAPS Soundings and SPoRT ozone products with forecasters
- Monitored hurricane activity August through October
  - Much of the activity was in the Central Atlantic
  - Matthew was the only Major Hurricane to impact the U.S.
  - Matthew's ET was not primarily driven my stratospheric air interaction

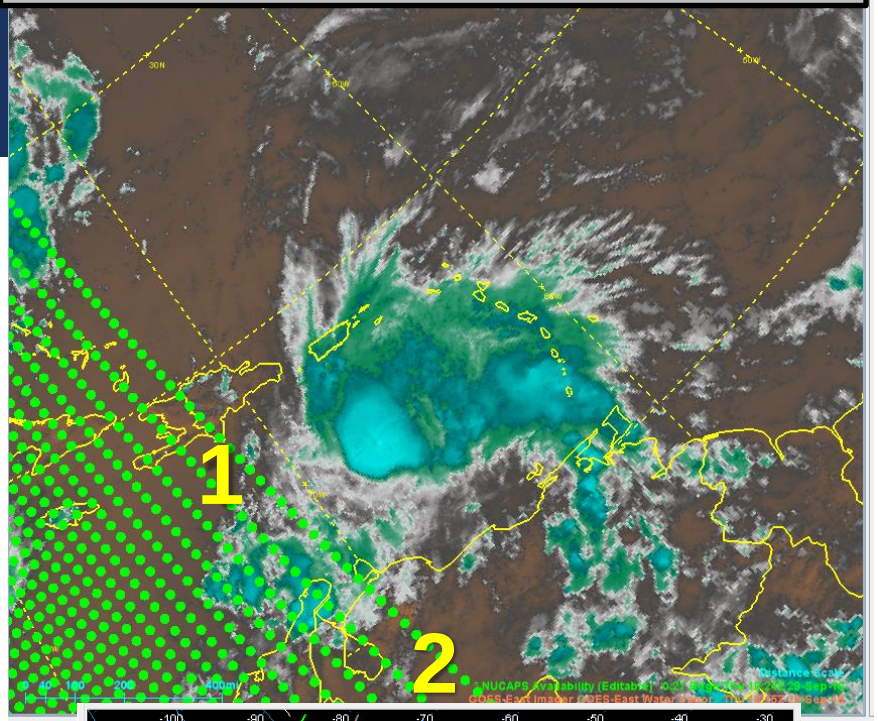


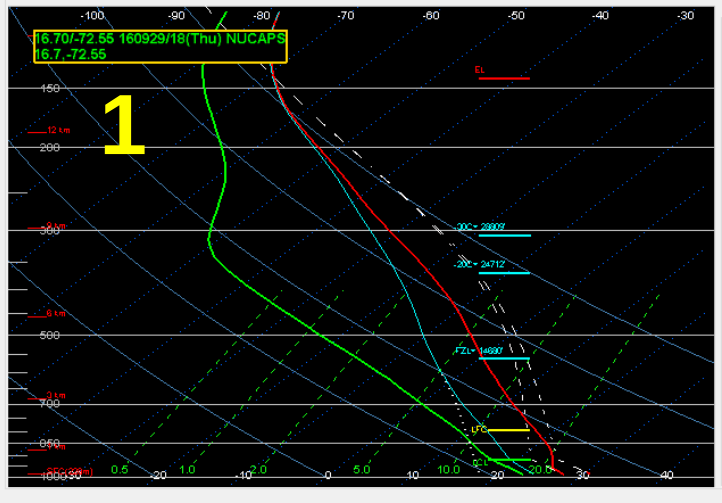
http://www.nhc.noaa.gov/tafb_latest/tws_atl_latest.gif

MATTHEW ANALYSIS

- Matthew underwent rapid intensification in a high shear environment with unfavorable dynamics
  - Can NUCAPS Soundings provide more information on why Matthew developed in an unfavorable environment?
  - NHC requested post-analysis to discuss utility of NUCAPS Soundings for Rapid Intensification

1815 UTC GOES-13 Water Vapor and
1824 UTC NUCAPS Soundings 29 Sept. 2016





https://nasasport.wordpress.com/2016/10/05/nucaps-soundings-and-hurricane-matthew/

SUMMARY

- SPoRT is working with the JPSS Proving Ground and the National Hurricane Center to testbed the utility of CrIS/ATMS Soundings to anticipate hurricane tropical to extratropical transition.
- The goal of this project is to demonstrate how NUCAPS infrared retrieved temperature, moisture, and ozone profiles can complement the Air Mass RGB imagery by giving forecasters insight about the vertical distribution atmospheric variables that are important for anticipating tropical to extratropical transition events.
- A tropopause level product was developed as part of the suite of SPoRT ozone products to compliment the Air Mass RGB product with quantitative data.
- Short-applications based training material was created.
- SPoRT is working on a Hurricane Matthew post-analysis to discuss the utility of NUCAPS Soundings for Rapid Intensification

REFERENCES

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QUESTIONS?

SPORT

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http://weather.msfc.nasa.gov/sport/

https://nasasport.wordpress.com/

http://twitter.com/NASA_SPoRT

http://www.facebook.com/NASA.SPoRT